REQUEST FOR EXPERIMENTAL SPECIAL TEMPORARY AUTHORIZATION

New Cingular Wireless PCS, LLC
Exhibit 1

NARRATIVE STATEMENT

Pursuant to Section 5.61 of the Commission's rules, 47 C.F.R. §5.61, New Cingular Wireless PCS, LLC, a subsidiary of AT&T Inc. ("AT&T") hereby respectfully requests special temporary authority ("STA") beginning May 1, 2014 to test the impact of using a Power Spectral Density ("PSD") measure as an alternative to an Effective Radiated Power ("ERP") measure for determining cellular base station power transmission limits. This testing is intended to assure that public safety systems operating in adjacent bands will not experience an increased risk of interference should the Commission revise its cellular base station power limits to include a PSD measure as an alternative to the existing ERP measure.

In support of this request, the following is shown:

1) Applicant's Name, Address, and FCC Registration Number ("FRN"):

Applicant Name:	New Cingular Wireless PCS, LLC
FRN:	0003291192
Address:	3300 E. Renner Road, B3132 Richardson, TX 75082

2) Description of Operation and Purpose of Test:

On July 18, 2013, AT&T filed a request for a limited waiver of Section 22.913 of the Commission's rules. Section 22.913 requires the use of an Effective Radiated Power ("ERP") measure for determining cellular base station power transmission limits. AT&T had proposed that the current rule be restated to include a power spectral density ("PSD") measure as an alternative to the ERP measure. Specifically, AT&T sought a waiver for markets in South Florida (see WT Docket No. 13-202). Because some Public Safety agencies expressed concern with AT&T's proposal, AT&T agreed to do testing. To conduct this testing AT&T needs a STA for no more than six months.

AT&T has selected three test sites to conduct its experiment. First, the testing team will conduct an "on/off" test to determine whether the public safety entity's transmission can be heard. Next, AT&T will establish baseline RF parameters and conduct voice quality tests on the public safety systems at the selected area.

The testing team will work to clear any existing interference in the test area, and then AT&T will modify the RF site parameters on the Cellular B band to emulate PSD conditions. The public safety representatives will then perform necessary tests at various distances and locations around the AT&T site. AT&T intends to deploy LTE carriers on its cellular spectrum and, once LTE is installed and transmitting, it will repeat the test to ensure that interference is not caused to public safety operations.

3) Need for an STA and Expedited Treatment**:**

AT&T requests an STA so that it can promptly conduct its testing and resolve any issues necessary to enable the Commission to grant AT&T's request for waiver. All parties agree that prompt resolution of these issues is essential.

4) Dates of Operation:

May 9, 2014 through November 9, 2014

5) Class(es) of Station(s):

Transmitter	Class	Radius of Operation
1	Fixed	Five Miles
2	Fixed	Five Miles
3	Fixed	Five Miles

6) Location(s) of Proposed Operations:

Transmitter	Address	Latitude	Longitude
1	9566 Southwest 40th Street Miami, FL 33165	25.7322	-80.3499
2	15607 Southwest 88th Street Miami, FL 33193	25.6851	-80.4451
3	4861 Southwest 140th Avenue Miami, FL 33175	25.7221	-80.4198

7) Equipment To Be Used:

Manufacturer	Model	# of Units	Prototype?
Ericsson	RBS3206 (Base Station)	1	No
Ericsson	KRC11822/5 RU22 (Radio)	2	No

8) Frequencies Desired:

869-894 MHz (cellular base station frequencies)

9) Power Levels:

Maximum ERP: 250 watts per MHz
Transmitter Power Output: 60 watts

10) Type of Emission, Modulation Technique, and Bandwidth Required:

Type of Emission	Modulation	Bandwidth
5M00DXW	QPSK	5 MHz per carrier
5M00DXW	16QAM	5 MHz per carrier
5M00DXW	64QAM	5 MHz per carrier

11) Overall Height of Antenna(s) Above Ground:

Transmitter	Height (ft)
1	102
2	101
3	76

This experiment will only involve the use of existing antennas, and no changes will be made to these antennas that would increase the height of the structure. Moreover, no antennas used in connection with the proposed operation will require further registration or approval under FAA or FCC rules and regulations. As such, AT&T has not completed the application form questions relating to antenna height and FAA matters.

12) Other Matters:

Please see attached Request for Waiver filed by AT&T in association with this testing.

13) Contact Information:

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July 22, 2013

By Messenger

ACCEPTED/FILED

JUL 22 2013

Federal Communications Commission
Office of the Secretary

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: AT&T Request for Rule Waiver

Dear Ms. Dortch:

On July 18, 2013, AT&T Filed a Request for Waiver of Section 22.913 of the Commissions Rules to Permit AT&T to use a PSD Measurement in the Cellular Bands of a Limited Number of Test Markets. AT&T inadvertently did not include the attachment with the filing. Attached is the corrected version of the filing with the attachment. If you have any questions, please do not hesitate to contact me at (202) 457-2040.

Sincerely,

/s/ William Roughton
General Attorney
AT&T Services, Inc.

Attachment

BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C.

In the Matter of	)
	)
Requests for Waiver of Section 22.913 of the Commission's Rules to Permit AT&T to Use a PSD Measurement in the Cellular Bands of a Limited Number of Test Markets	))))

REQUEST FOR RULE WAIVER

Pursuant to Section 1.925 of the Federal Communications Commission's (the "Commission") rules, AT&T Services, Inc., on behalf of AT&T, Inc. and its subsidiaries ("AT&T"), hereby respectfully requests a limited waiver of Section 22.913 of the Commission's rules.[1] Section 22.913 requires the use of an Effective Radiated Power ("ERP") measure for determining cellular base station power transmission limits. AT&T has proposed[2] that the current rule for cellular base station power limits should be restated to include a power spectral density ("PSD") measure as an alternative to the ERP measure. Offering cellular carriers the option to use a PSD measure for calculating cellular base station power limits would eliminate unintended penalties on the deployment of advanced digital broadband modulation schemes such as Long Term Evolution ("LTE") in the cellular bands. The markets for which AT&T seeks a waiver of the ERP requirement are in south Florida and are comprised of the contiguous CMA markets of West Palm

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[1] 47 C.F.R. § 22.913.

[2] *In the Matter of Amendment of the Commission's Rules Governing Radiated Power Limits in the Cellular Radio Service Frequency Bands,* Petition for Expedited Rulemaking and Request for Waiver, RM-11660, DA-12-701 (filed February 29, 2012) ("PFR"). The request for a waiver was not placed on public notice. With this filing, AT&T moves to withdraw that broad waiver request and substitute this narrower request in its place.

Beach (CMA072), Miami (CMA012) and Monroe, FL-11 (CMA 370). Exact geographic boundaries are defined by these licenses CGSAs.[3]

Grant of the requested relief would be in the public interest because: (i) the waiver would remove disparities between radio services that limit cellular carriers' ability to deploy the most efficient and advanced modulation techniques;[4] and (ii) the waiver would promote the deployment of mobile broadband services consistent with the policy goals enumerated in the National Broadband Plan. Accordingly, such relief is consistent with the public interest and the Commission's goal of promoting widespread competitive wireless broadband services to all Americans.

BACKGROUND

On February 29, 2012, AT&T filed a petition for expedited rulemaking and a request for a blanket waiver of 47 C.F.R. § 22.913 pending disposition of its PFR.[5] Thereafter, the Wireless Telecommunications Bureau sought comment on the PFR only, taking no action on the requested waiver.[6]

No carrier commenting on AT&T's proposed rule change opposed the proposed revision to the power limits rule. For example, United States Cellular Corporation ("USCC") said

> We agree with AT&T that the FCC should provide assurance in its rules that wireless carriers using LTE will be able to operate with ERP levels sufficient to provide adequate coverage on cellular as well as PCS and A WS frequencies.[7]

Verizon Wireless, while agreeing with AT&T's proposal, argued that *even higher* PSD limits should be adopted by the Commission.[8] Two other carriers commenting on AT&T's PFR sup-

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[3] For CMA 12, the licenses are KNKA225 and KNKA364; for CMA 72: KNKA264 and KNKA355, and for CMA 370: KNKN793 and WPSJ791

[4] *See,* PFR at 9–12.

[5] *See,* n. 2 above.

[6] *Wireless Telecommunications Bureau Seeks Comment On Petition For Rulemaking Filed By AT&T to Make 800 MHz Cellular Base Station Power Rules Consistent With Rules for Other Mobile Broadband Services,* DA-12-701 (Released: May 2, 2012).

[7] *Id.,* Comments of USCC at 3.

ported the requested rule change to section 22.913;[9] but sought changes in the relief AT&T requested. One of these two comments expressed some disagreement with different elements of AT&T's original proposal;[10] the other opposed only the request for blanket waiver.[11] Cincinnati Bell's objection misinterpreted AT&T's request to mean that the ERP limits for cellular base stations "should be restated as power spectral density ("PSD") limits."[12] Again, AT&T pointed out in its reply comments that the proposed rule change intended only to permit the use of a PSD *measure as an alternative to, and not as a replacement for*, the ERP standard currently in the rule. Consequently, neither of those comments acts as a bar to this waiver request. Furthermore, even though neither of the comments presents a claim of increased interference, it is worth noting that the market for which the waiver is sought is not adjacent to any market of Cincinnati Bell or Bluegrass Cellular.

In this petition for a waiver of section 22.913 of the Commission's rules, AT&T seeks authority to initiate power spectral density testing and operations in the cellular band in South Florida. The testing and operations will take place subject to conditions intended to assure that

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[8] Comments of Verizon Wireless at 7.

[9] Comments of Broadpoint, LLC d/b/a Cellular One, Cincinnati Bell Wireless LLC, NE Colorado Cellular, Inc., Smith Bagley, Inc., and Union Telephone Company d/b/a Union Wireless ("Cincinnati Bell") RM-11660 filed June 1, 2012; Comments of Bluegrass Cellular, Inc. ("Bluegrass") RM-11660 filed June 1, 2010.

[10] *See,* Comments of Cincinnati Bell.

[11] Bluegrass Cellular favored an "FCC initiation of a rulemaking to consider modification of FCC Rule Section 22.913 to make cellular Effective Radiated power ("ERP") rules more consistent with other mobile broadband services;" but opposed the grant of the waiver. As AT&T pointed out in its reply comments (and as noted above), the initial, blanket waiver request was never put on public notice. Furthermore, in filing this limited waiver request, AT&T has also moved to withdraw the blanket waiver from the FCC's consideration. Bluegrass's complaint is, then, moot, especially because the areas for which AT&T seeks a waiver are not contiguous to, or even close to, Bluegrass Cellular's service territories.

[12] Cincinnati Bell Comments at 2. Under this reading of the proposed rule change, Cincinnati Bell feared that limiting ERP to the power spectral density AT&T proposed would require 2G GSM/EDGE systems to pull back their boundaries to cover smaller areas. Obviously, since Cincinnati Bell could continue to use the existing ERP power limit measure of section 22.913 under AT&T's proposal, its cell site boundaries would remain unchanged.

public safety systems operating in adjacent bands will not experience an increased risk of interference. A prompt grant of this waiver will enable AT&T to begin the process of deploying advanced digital broadband modulation schemes in the cellular bands. Doing so will enable AT&T to meet the constantly growing demand of customers for more data capacity and higher wireless data speeds. Consistent therewith, AT&T respectfully submits this waiver request to employ a power spectral density measure for cellular base station emission limits in the south Florida markets noted above.[13]

WAIVER REQUEST

Under Section 1.925(b)(3) of its rules, the Commission may grant a request for waiver if the applicant demonstrates that: (i) the underlying purpose of the rule would not be served or would be frustrated by its application to the instant case, and that the grant of the requested waiver would be in the public interest; or (ii) in view of unique or unusual factual circumstances, application of the rule(s) would be inequitable, unduly burdensome, or contrary to the public interest, or the applicant has no reasonable alternative.[14] In this case, as discussed below, AT&T submits that a waiver of the power limits to permit AT&T to use a PSD measurement in the designated south Florida markets pending the outcome of the proposed rulemaking would be in the public interest.

Carriers have experienced extraordinary increases in the volume of data generated by consumers and businesses as a result of the popularity and ubiquity of smartphones and other data-enabled devices. Having pioneered devices like the iPhone and aggressively promoted the latest technologies and applications, AT&T has also documented that its network has borne the

[13] *See,* n.3

[14] *See,* 47 C.F.R. §1.925; *WAIT Radio v. FCC,* 418 F.2d 1153 (D.C. Cir. 1969).

brunt of a substantial amount of this newly generated traffic.[15] Over the last five years, AT&T has invested nearly $98 billion[16] to improve and expand its wireless and wireline networks. We expect to invest in the range of $21 billion in 2013.[17] Notwithstanding that massive investment, AT&T remains critically constrained by access to spectrum; yet, if it is to maintain a high-quality level of service for its customers, AT&T must nevertheless rapidly and aggressively roll-out LTE services even as it faces these spectrum constraints.

To this end, AT&T plans to deploy LTE carriers on its cellular spectrum in a number of markets beginning the first quarter of 2014 but needs authorization to start planning/deployment process by September 2013. The need for relief as soon as possible is critically important for a number of reasons. First, if AT&T can make use of its existing 800 MHz cell spacing for LTE services, there are great efficiencies in deployment, since the roll-out will use existing infrastructure. Grant of this waiver, then, will enable AT&T to determine if its existing 800 MHz cell spacing is suitable for LTE services and whether site upgrades, such as backhaul, may have to take place to maximize LTE benefits. Second, if testing shows that AT&T must adopt cell spacing that is denser than its existing site inventory, it will have to begin site selection immediately to extend its network infrastructure to a range of new sites. These cell site selections must begin at the earliest possible date because it has become increasingly difficult and time consuming to

[15] *See,* http://www.macworld.com/article/1155757/attmobiledata.html reporting that AT&T's mobile data traffic grew 3,000% from 2007 to 2010.
[16] The nearly $98 billion is based on AT&T's construction and capital expenditures for the years 2008-2012. *See,* AT&T 2012 Annual Report at 30.
[17] AT&T Inc. Quarterly Report (1Q 2013 10-Q).

identify and secure suitable sites.[18] Grant of the requested waiver will allow AT&T to begin timely planning for LTE deployment.

A PSD-based cellular power limit will not cause increased harmful interference to adjacent frequency bands. As noted in its PFR, AT&T compared the potential interference effects of various wireless network arrangements on public safety receivers. That study[19] addressed three near/far interference mechanisms common in public safety interference environment – Intermodulation, Out of Band Emissions ("OOBE"), and Receiver Overload. The benchmark used to measure significant interference was a rise in the receiver's noise floor greater than 1 dB for intermodulation and OOBE interference. For receiver overload, the benchmark was a received interference level higher than the overload limit of the affected receiver. Public safety receiver performance was based upon current models with relatively wide open front end filtering encompassing the range from 851-869 MHz. The Public Safety receiver bandwidths of 12.5 and 25 KHz were assumed for the study.

By examining five different cases that represent AT&T's past, present, and future wireless networks, the study showed there would be no significant effects upon adjacent services. The cases are composed of GSM, UMTS and LTE systems in various configurations in the cellular band. The purpose of this comparison was to show that future deployments of 2X2 MIMO[20] LTE in the cellular bands under a PSD limit would maintain the *status quo* with respect to the potential interference impacts on adjacent services—and in particular, the Public Safety services.

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[18] *See, e.g.*, Reply Declaration of William Hogg, Applications of AT&T Inc. and Deutsche Telekom AG, WT Docket No. 11-65 (filed June 10, 2011) at 26 (available at: http://apps.fcc.gov/ecfs/document/view?id=7021686835 (last visited Feb. 28, 2012)).
[19] The study is attached as Appendix A.
[20] To multiply throughput of a radio link, multiple antennas (and multiple RF chains accordingly) are put at both the transmitter and the receiver. This system is referred to as Multiple Input Multiple Output ("MIMO"). A MIMO system with a similar count of antennas at both the transmitter and the receiver in a point-to-point ("PTP") link is able to increase the system throughput with every additional antenna.

With respect to intermodulation interference, at the three distances from the cellular base station site (40 meters, 200 meters, and 1000 meters) for all migration paths, the noise floor rise for LTE deployments with MIMO and PSD rules relief were significantly less than present technology deployments. For OOBE at the three distances from the cellular base station site for all migration paths, all noise floor rises were below 1 dB. This rise in the interference floor is insignificant in practice and is still well under the 1 dB degradation in the noise floor of the public safety mobile receiver. Finally, for overload interference, the study showed LTE deployments did not increase the number of possibilities of such interference above that of existing deployments.

The study results demonstrate that the interference environment into Public Safety units from 2X2 MIMO LTE cellular deployments planned by AT&T is not appreciably different from that of existing cellular deployments—and in some cases it is better. The study results also showed that a power spectral density limit based on a maximum power level of 2500 watts (2500 Watts/10 MHz or 250 Watts/MHz for non-rural areas) and 5000 watts (5000 Watts/10 MHz or 500 Watts/MHz in rural areas) should exhibit about the same or less interference impacts as existing deployments.

As noted, AT&T's petition seeks to maintain the status quo in the RF environment of neighboring public safety service areas. This conservative RF approach also applies to CMRS service areas as well. AT&T chose its PSD limit based on existing transmit power levels at its sites. By maintaining the existing total power levels at its sites, AT&T's power levels into adjacent public safety and CMRS service areas with the new PSD limit would be the same as before. AT&T will not inject increased signal energy into these bordering areas and will not increase the noise level in those areas. Under the AT&T PSD limit, the power injected into neighboring receivers either in adjacent areas or co-located sites does not increase but remains the same. Consequently, the effect on neighboring and co-located systems – both public safety and cellular services – is minimal.[21]

This is especially true for neighboring cellular systems because *there are no neighbors* for AT&T's 850 A band licenses and the FL11 (Monroe) 850B license. Hence, no harmful effect to neighboring systems is possible in those bands. For the remaining B band cellular licenses, Verizon, who supports AT&T's PFR, is the only neighbor. Aside from its support of AT&T's PFR, Verizon has proposed *higher* PSD limits than those proposed by AT&T,[22] a fact that suggests Verizon Wireless itself anticipates no harmful effects from the grant of this waiver request.

For these reasons, AT&T requests that the FCC grant it a waiver to permit it to use the PSD measurements specified in its PFR in lieu of the power limits currently specified in section 22.913 of the rules for testing and operations in the south Florida markets noted above. AT&T fully expects that any such waiver would be conditioned on the outcome of the rulemaking proceeding proposed in its PFR Grant of the requested relief would be in the public interest because: (i) the waiver would remove disparities between radio services that limit cellular carriers' ability to deploy the most efficient and advanced modulation techniques; and (ii) the waiver would promote the deployment of mobile broadband services consistent with the policy goals enumerated in the National Broadband Plan. Moreover, the waiver—conditioned on the outcome of the proposed rulemaking—would not undermine the deliberative process relative to

[21] Furthermore, to the extent that the PSD measure would change an AT&T CGSA's contour, AT&T will manage the power level in the CGSA until the company can make the appropriate filings with the Commission and receive approval for the changed contours.

[22] "However, rather than adopting relatively low PSD limits as AT&T proposes, the Commission should adopt both PSD and power flux density ("PFD") limits. By adopting PSD and PFD limits, the Commission can adopt PSD limits consistent with those adopted for other bands, resulting in better coverage and data throughput, while still protecting adjacent licensees from harmful interference." Reply Comments of Verizon Wireless at iii.

adopting PSD limits for cellular carriers more broadly. For the foregoing reasons, AT&T urges the Commission to act quickly and grant AT&T permission to use PSD-based power measurements for its cellular systems.

CONCLUSION

For the reasons discussed above, AT&T respectfully requests that the Commission waive section 22.913 of the rules, which require use of Effective Radiated Power ("ERP") measure for determining cellular base station power transmission limits, and permit AT&T to initiate power spectral density testing and operations in the cellular band in areas of southern Florida described herein.

Respectfully submitted,

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Counsel for AT&T Inc.

July 18, 2013

Radio Access and Devices – Wireless Technology Strategies

Date: **March 21, 2013**

Subject: **A Comparison of the Impacts on Public Safety Receivers from the Various Wireless Technologies used in AT&T's Migration from Narrowband GSM to Broadband LTE Employing Both the 850 MHz A and B Block Licenses In the CMRS Cellular Band**

Author: **Doug Duet**
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Abstract

The FCC Rules for the 850 MHz band were designed to accommodate first generation AMPS (Advanced Mobile Phone System) analog cellular service. Over the years, carriers deployed digital services in the 850 MHz bands, and eventually sunset analog services. Carriers currently use the 850 MHz band for technologies that support mobile broadband, such as UMTS. As the industry moves toward fourth generation LTE (Long Term Evolution) technology coupled with the use of MIMO (Multiple Input Multiple Output) techniques for spectral efficiency improvements, it is appropriate to consider whether the rules for this band relating to power measurement, which were adapted for technology deployed almost 30 years ago, should be revised to accommodate LTE. In band plans adopted more recently to accommodate mobile broadband deployment, the Commission has adopted a Power Spectral Density approach. This paper presents the results of a study that considers whether making such a change to the 850 MHz rules to accommodate contemporary commercial mobile broadband deployments where the licensee holds both the A and B block licenses would increase the likelihood of interference to adjacent users of the Public Safety bands.

The study addressed the interference impacts on Public Safety receivers under five different cases that are representative of AT&T's past, present, and future network comprising GSM, UMTS and LTE systems in various configurations in the cellular band where the licensee holds both the A and B block licenses. Results of this "real world" study again leads AT&T to conclude that a power limit based on a Power Spectral Density measure will not increase the possibility of harmful interference to adjacent bands and would maintain the "status quo" with respect to the potential impact on users of adjacent spectrum, such as the Public Safety Radio Service. The "real world" study results also supported a Power Spectral Density limit of 250 Watts/MHz in non-rural areas and 500 Watts/MHz in rural areas proposed by AT&T.

1. Introduction

The FCC Rules for the 850 MHz band were designed to accommodate first generation AMPS (Advanced Mobile Phone System) analog cellular service. Over the years, carriers deployed digital services in the 850 bands, and eventually sunset analog services. Carriers currently use the 850 MHz band for technologies that support mobile broadband, such as UMTS (Universal Mobile Telecommunications System). As carriers migrate their wireless networks to fourth generation (4G) LTE (Long Term Evolution) technology and use MIMO (Multiple Input Multiple Output) techniques for spectral efficiency improvements, the FCC Rules governing the radiated power of transmitters in the Cellular Radiotelephone Service have come into question. MIMO uses multiple antennas or multiple antenna elements at both the transmitter and receiver to create multiple distinct spatial channels between the transmitter and the receiver using the same radio channel. AT&T plans to use 2x2 MIMO in its 850 MHz LTE deployments. 2x2 MIMO uses two transmitters operating on the same carrier channel but carrying two different information streams to create two separate spatial channels. Since two spatial channels are created using a single radio carrier, spectral efficiency is increased. The current FCC Rule governing radiated power in the Cellular Radiotelephone Service (Section 22.913) states - *the effective radiated power of base transmitters and cellular repeaters must not exceed 500 watts.* Since this power limit was enacted prior to the development and use of MIMO techniques, it was generally understood that a single transmitter used a single carrier frequency and the power requirement was related to this carrier frequency. A 2x2 MIMO deployment, which employs a single carrier channel on two transmitters, must split the maximum radiated power given in the FCC Rules between the two MIMO transmitters. This power split reduces the service coverage area of the transmitters operating in the MIMO mode compared to that of a single transmitter deployment.

In 2004, recognizing the problem posed by the then current power limitation rules, CTIA offered a technologically neutral proposal to modify base station power limits for PCS licensees. Subsequently, the Commission expanded this proposal to include not only PCS, but also cellular radio service and other service bands. In 2008, following comments on the proposal, the FCC revised the radiated power rules for certain services, notably PCS and AWS, but declined to extend the revision to cellular radio service because the frequencies immediately adjacent to the 850 MHz cellular band were undergoing significant restructuring and "until [it could] better assess the impact of additional power limit changes" on the possibility of harmful interference to adjacent bands. Since then, re-banding of services adjacent to the cellular band is almost complete and there has been adequate time to understand the interference concerns, if any, due to the adoption of Power Spectral Density (PSD) rules in PCS and AWS bands. Such a PSD limit would allow the use of MIMO techniques in the 850 MHz band without requiring a reduction in the service coverage area, and would be more consistent with FCC broadband power limit rules in other bands. A PSD limit specifies the amount of power that is distributed with frequency and in the case of the cellular radiotelephone service, it is the amount of power distributed over a radio channel. If the maximum radiated power in a 5 MHz channel is 1500 watts, the PSD would be 300 watts/MHz (1500 watts/5 MHz).

Believing that a PSD measure should now be adopted for the cellular bands, AT&T conducted a technology interference comparison analysis of its third generation (3G) UMTS and 4G LTE technologies to show that a power limit based on a Power Spectral Density measure will not increase the possibility of harmful interference to adjacent bands and would also maintain the "status quo" with respect to the potential impact on users of adjacent spectrum, such as the Public Safety Radio Service. The results of the technology interference comparison supported AT&T's belief. The study results also supported a Power Spectral Density limit greater than 100 Watts/MHz.

To further bolster AT&T's belief that a power limit based on a Power Spectral Density measure will not increase the possibility of harmful interference to adjacent bands, AT&T completed a second "real world" study which determined the interference impacts on users of spectrum adjacent to one of the two 850 MHz license blocks as a result of its technology migration through the years – from second generation (2G) GSM (Global Systems for Mobile Communications) to 4G LTE with MIMO. AT&T's technology migration study commences with the deployment of 2G GSM technology employing a tri-sectored frequency reuse pattern of N=12 that typically allowed in a single 850 MHz license block on average up to five GSM carriers per sector. With the migration to broadband 3G UMTS technology, some GSM carriers were replaced with a single UMTS carrier. A typical sector in an initial 3G network would include one UMTS and three GSM carriers. As broadband demand increased, the spectrum for a second UMTS carrier was again re-farmed from existing GSM carriers. A typical congested metro market with a single 850 MHz license block deploys two UMTS carriers along with two GSM carriers per sector. As the data traffic demand increased, a migration to 4G LTE in the cellular bands will be necessary. LTE deployments will precede by replacing one of the UMTS carriers with a 5 MHz LTE carrier employing 2X2 MIMO. Initial deployments of LTE with a single 850 MHz license block will include a 5 MHz UMTS carrier, a 5 MHz LTE carrier, and two GSM carriers in the cellular band. The final migration will be to replace the remaining UMTS and GSM carriers and to upgrade the 5 MHz LTE carrier to a 10 MHz LTE carrier. The LTE deployments will be with two transmitters per carrier/sector as compared to a single transmitter per carrier/sector with UMTS. The study results suggested that the interference environment into Public Safety portable and mobile units from 2X2 MIMO LTE cellular deployments with a single cellular block allocation was not appreciably different than that from existing technologies in the cellular band.

This paper documents the results of a similar study of the technology migration in AT&T's network where a licensee holds both the A and B license blocks. Under this license environment, AT&T's technology migration commences with the deployment of 2G GSM technology employing a tri-sectored frequency reuse pattern of N=12 that typically allowed in two 850 MHz license blocks on average up to ten GSM carriers per sector. With the migration to broadband 3G UMTS technology, some GSM carriers were replaced with two UMTS carriers. A typical sector in an initial 3G network would include two UMTS and six GSM carriers. As broadband demand increased, the spectrum for two more UMTS carriers was again re-farmed from existing GSM carriers. A typical congested metro market with two 850 MHz license blocks deploys four UMTS carriers along with four GSM carriers per sector. As the data traffic demand increased, a migration to 4G LTE in the cellular bands will be necessary. LTE deployments will proceed by replacing two of the UMTS carriers with two 5 MHz LTE carriers employing 2X2 MIMO. Initial deployments of LTE with two 850 MHz license blocks will include two 5 MHz UMTS carriers, two 5 MHz LTE carriers, and four GSM carriers in the cellular band. The final migration will be to replace the remaining UMTS and GSM carriers and to upgrade the 5 MHz LTE carriers to 10 MHz LTE carriers. The LTE deployments will be with two transmitters per carrier/sector as compared to a single transmitter per carrier/sector with UMTS.

1. Modeling the Interference Environment

Modeling the interference environment consisted of the following five steps:

1. Model the interference path
2. Determine the transmitter and receiver characteristics
3. Model the interference mechanisms
4. Calculate the interference levels and determine their impacts

1.1 Modeling the Interference Path

Since the interference network environment is that of a standard cellular architecture, two propagation loss models were used to calculate path loss. These two propagation loss models were the HATA loss models and the modified Friis Transmission Loss model. The HATA models are the most widely used radio frequency propagation models for predicting the behavior of cellular transmissions. Since the HATA models are accurate for link distances between 1 and 20 kilometers, another model was needed for paths closer to the cell site. The Friis Transmission Loss model is ideal for paths between two isotropic antennas in free space (Line-of-Sight) and can be modified for paths other than free space (Non-Line-of-Sight). All loss models were incorporated into the Friis Transmission Equation which relates received power, transmit power, antenna gains and path loss in order to calculate interference levels. For line-of-sight paths a propagation constant of 2 was used and for non-line-of-sight paths, a propagation constant of 2.4 was used. Cellular antenna heights for non-rural areas used the average antennas height in AT&T's non-rural network – 30 meters. For rural areas where antenna heights are generally higher, antenna heights of 47 and 92 meters were used.

1.2 Determining the Transmitter and Receiver Characteristics

The transmitter and receiver characteristics were:

- Maximum transmit power
- Base station antenna gains and discrimination
- Transmission line loss
- Transmitter sideband emission levels
- Public Safety receiver noise floor
- Minimum mobile Adjacent Channel Rejection Ratio
- Minimum portable Adjacent Channel Rejection Ratio
- Public Safety mobile antenna gain: From an Internet site on Public Safety equipment
- Public Safety portable antenna gain: From an Internet site on Public Safety equipment
- Public Safety Receiver Overload level

- Third Order Intercept Point calculation: From *Motorola paper by Bruce Oberlies – "Public Safety Interference Environment – Raising Receiver Performance Requirements"*
- Third Order Interference Level calculation: From Aeroflex Application Note on Intermodulation Distortion on the website www.aeroflex.com.

1.3 Modeling the Interference Mechanism

The three near/far interference mechanisms common in Public Safety interference environments were modeled in the following manner:

1. Intermodulation – The receive interference level at the input to the Public Safety receiver's front end was calculated using the appropriate Friis Transmission Equation. The study assumed that the GSM channels were transmitting at 500 Watts, UMTS channels were transmitting at 500 Watts, and LTE at 500 Watts/transmitter-antenna for a 5 MHz channel and 1000 Watts/transmitter-antenna for a 10 MHz channel. Since Effective Radiated Power level is the power level radiating from the base station's antenna, no transmission line loss or base station antenna gain was included in this calculation. It was assumed that these levels were the levels of the two interfering signals creating the intermodulation product. The third order intercept point was calculated using the formula in the Motorola paper and this value was used in the Aeroflex equation with the interference levels calculated from the Friis Transmission Equation to obtain the level of the third order product in the receiver.

2. Transmitter Sideband Emissions - The transmitter sideband emission level at the input to the Public Safety receiver's front end was calculated using the appropriate Friis Transmission Equation. The sideband transmit power level at the output of the transmitter used in this equation was the measured spurious emissions level given by the manufacturer. For this calculation in the Friis Transmission Equation, transmission line loss and base station antenna gain were included.

3. Receiver Overload - The received interference level at the input to the Public Safety receiver's front end was calculated using the appropriate Friis Transmission Equation. The cellular base station transmit power level used in this equation was the maximum Effective Radiated Power level specified in the FCC Rules for Cellular services in the 850 MHz cellular band for 2G and 3G technologies (GSM channels were transmitting at 500 Watts, UMTS channels were transmitting at 500 Watts, and LTE at 500 Watts/transmitter-antenna for a 5 MHz channel and 1000 Watts/transmitter-antenna for a 10 MHz channel). Since Effective Radiated Power level is the power level radiating from the base station's antenna, no transmission line loss or base station antenna gain was included in this calculation.

1.4 Interference Levels and Their Impacts

An Excel spreadsheet was developed to make the above mentioned calculations and determine the impacts of the various interference mechanisms. For the intermodulation interference calculation and the transmitter sideband emission interference calculation, the criteria used to determine impact was a rise in the receiver's noise floor. For Receiver Overload interference calculations, the criteria used to determine impacts was that any interfering level that was less than the specified overload point of the receiver is an acceptable interfering level. For this study only the relative levels of the interference environments are compared. Only in situations where a technology's interference environment level is no worse than the existing technology's interference environment level can the interference level be deemed acceptable (Status Quo).

The study addresses the interference impacts on Public Safety receivers under five different cases that are representative of AT&T's past, present, and future network comprising GSM, UMTS and LTE systems in various configurations in those areas where AT&T holds both the A and B 850 MHz license blocks in the cellular band. Case one represents an initial 2G GSM deployment of ten GSM carriers. Case two addresses the migration to two UMTS carriers and six GSM carriers. Case three represents the migration to four UMTS carriers along with four GSM carriers per sector. Case four represents a migration to 4G LTE with two 5 MHz UMTS carriers, two 5 MHz LTE carriers with MIMO, and four GSM carriers. The final migration, Case five, will be to two 10 MHz LTE carriers with MIMO.

2. Study Results

With a single GSM channel's transmit power level set to 500 Watts, a single UMTS channel set to 500 Watts, and a LTE channel set to 500 Watts/transmitter-antenna for a 5 MHz channel and 1000 Watts/transmitter-antenna for a 10 MHz channel, the results of the Excel spreadsheet calculations of interference into Public Safety receivers with bandwidths of 25 and 12.5 KHz from the five migration cases for non-rural and rural environments are shown in Tables 1 through 12. Bracketed numbers in the overload tables are received overload interference levels in dBm.

2.1 Intermodulation Interference Impacts

	PS RECEIVER BANDWIDTH = 25 KHz				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 2 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	5000 W	4000 W	4000 W	5000 W	4000 W
Allowed Now	YES	YES	YES	NO	NO
40	9.4362	9.4362	9.4362	9.4362	0.0173
200	6.4700	6.4700	6.4700	6.4700	0.0076
>1000	0.0482	0.0482	0.0482	0.0482	0.0000

DISTANCE TO MOBILE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	5000 W	4000 W	4000 W	5000 W	4000 W
Allowed Now	YES	YES	YES	NO	NO
40	18.0114	18.0114	18.0114	18.0114	0.1363
200	14.5468	14.5468	14.5468	14.5468	0.0607
>1000	0.3717	0.3717	0.3717	0.3717	0.0002

TABLE 1. Non-Rural Mobile Intermodulation Impacts

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 25 KHz				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 2 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	5000 W	4000 W	2000 W	5000 W	4000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0043	0.0043	0.0043	0.0043	0.0000
200	0.0019	0.0019	0.0019	0.0019	0.0000
>1000	0.0482	0.0482	0.0482	0.0482	0.0000

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	5000 W	4000 W	4000 W	5000 W	4000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0339	0.0339	0.0339	0.0339	0.0000
200	0.0104	0.0104	0.0104	0.0104	0.0000
>1000	0.0000	0.0000	0.0000	0.0000	0.0000

TABLE 2. Non-Rural Portable Intermodulation Impacts

DISTANCE TO MOBILE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 47 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**10,000 W**	**8000 W**	**8000 W**	**10,000 W**	**8000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	0.5766	0.5766	0.5766	0.5766	0.0000
200	8.9790	8.9790	8.9790	8.9790	0.0019
>1000	1.0994	1.0994	1.0994	1.0994	0.0001

DISTANCE TO MOBILE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 47 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**10,000 W**	**8000 W**	**8000 W**	**10,000 W**	**8000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	3.2957	3.2957	3.2957	3.2957	0.0003
200	17.5004	17.5004	17.5004	17.5004	0.0076
>1000	5.1913	5.1913	5.1913	5.1913	0.0006

DISTANCE TO MOBILE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 92 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**10,000 W**	**8000 W**	**8000 W**	**10,000 W**	**8000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	0.0000	0.0000	0.0000	0.0000	0.0000
200	0.0076	0.0076	0.0076	0.0076	0.0000
>1000	3.3683	3.3683	3.3683	3.3683	0.0003

DISTANCE TO MOBILE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 92 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0003	0.0003	0.0003	0.0003	0.0000
200	0.0601	0.0601	0.0601	0.0601	0.0000
>1000	10.1597	10.1597	10.1597	10.1597	0.0026

TABLE 3. Rural Mobile Intermodulation Impacts

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 47 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 1 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0001	0.0001	0.0001	0.0001	0.0000
200	0.0038	0.0038	0.0038	0.0038	0.0000
>1000	0.0002	0.0002	0.0002	0.0002	0.0000

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 47 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0006	0.0006	0.0006	0.0006	0.0000
200	0.0301	0.0301	0.0301	0.0301	0.0153
>1000	0.0013	0.0013	0.0013	0.0013	0.0000

	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 92 m)				
DISTANCE TO PORTABLE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0001	0.0001	0.0001	0.0001	0.0000
200	0.0038	0.0038	0.0038	0.0038	0.0000
>1000	0.0006	0.0006	0.0006	0.0006	0.0000

	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 92 m)				
DISTANCE TO PORTABLE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0000	0.0000	0.0000	0.0000	0.0000
200	0.0000	0.0000	0.0000	0.0000	0.0000
>1000	0.0051	0.0051	0.0051	0.0051	0.0000

TABLE 4. Rural Portable Intermodulation Impacts

The results above show that for intermodulation interference at the three distances from the cellular base station site (40 meters, 200 meters, and 1000 meters) for all migration paths, the noise floor rise for LTE deployments with MIMO were below 1 dB and were significantly less than present technology deployments. The higher and consistently uniform interference level for those cases involving GSM are driven only by much higher PSD of the GSM carrier. Thus this worst case interference effect remains the same regardless of the number of GSM carriers that are present. In practice where interference cases have been identified, judicious shuffling of the GSM carriers amongst various frequencies has allowed IM interference to be mitigated.

Tables 1 through 4 show Case 4, which is represented by each sector deploying two UMTS carrier transmitting at 500 W, two 5 MHz LTE carrier transmitting at 1000 W and four GSM carriers transmitting 500 watts each, will not cause any additional interference from intermodulation (IM) into Public Safety receivers as compared to existing UMTS or GSM systems.

2.2 Sideband Interference Impacts

	PS RECEIVER BANDWIDTH = 25 KHz				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	5000 W	4000 W	4000 W	5000 W	4000 W
Allowed by FCC Rules	Yes	Yes	Yes	No	No
40	0.0542	0.0432	0.0432	0.0542	0.0542
200	0.0414	0.0328	0.0328	0.0414	0.0414
>1000	0.0048	0.0038	0.0038	0.0048	0.0062

	PS RECEIVER BANDWIDTH = 12.5 KHz				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	5000 W	4000 W	4000 W	5000 W	4000 W
Allowed by FCC Rules	Yes	Yes	Yes	No	No
40	0.0542	0.0432	0.0432	0.0542	0.0542
200	0.0414	0.0328	0.0328	0.0414	0.0414
>1000	0.0048	0.0038	0.0038	0.0048	0.0062

TABLE 5. Non-Rural Mobile Sideband Impacts

	PS RECEIVER BANDWIDTH = 25 KHz				
DISTANCE TO PORTABLE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	5000 W	4000 W	4000 W	5000 W	4000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0272	0.0216	0.0216	0.0272	0.0272
200	0.0208	0.0164	0.0164	0.0208	0.0208
>1000	0.0024	0.0020	0.0020	0.0024	0.0030

	PS RECEIVER BANDWIDTH = 12.5 KHz				
DISTANCE TO PORTABLE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	5000 W	4000 W	4000 W	5000 W	4000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0272	0.0216	0.0216	0.0272	0.0272
200	0.0208	0.0164	0.0164	0.0208	0.0208
>1000	0.0024	0.0020	0.0020	0.0024	0.0030

TABLE 6. Non-Rural Portable Sideband Impacts

	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 47 m)				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0072	0.0056	0.0056	0.0072	0.0072
200	0.0262	0.0208	0.0208	0.0262	0.0130
>1000	0.0090	0.0072	0.0072	0.0090	0.0090

	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 47 m)				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0072	0.0432	0.0432	0.0072	0.0072
200	0.0262	0.0208	0.0208	0.0262	0.0262
>1000	0.0090	0.0072	0.0072	0.0090	0.0090

DISTANCE TO MOBILE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 92 m) CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0002	0.0002	0.0002	0.0002	0.0002
200	0.0016	0.0014	0.0014	0.0016	0.0016
>1000	0.0144	0.0114	0.0114	0.0144	0.0144

DISTANCE TO MOBILE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 92 m) CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0002	0.0002	0.0002	0.0002	0.0002
200	0.0016	0.0014	0.0014	0.0016	0.0016
>1000	0.0144	0.0114	0.0114	0.0144	0.0144

TABLE 7. Rural Mobile Sideband Impacts

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 47 m) CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0036	0.0028	0.0028	0.0036	0.0036
200	0.0130	0.0104	0.0104	0.0130	0.0066
>1000	0.0046	0.0036	0.0036	0.0046	0.0046

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 47 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0036	0.0028	0.0028	0.0036	0.0036
200	0.0130	0.0104	0.0104	0.0130	0.0130
>1000	0.0058	0.0036	0.0036	0.0058	0.0046

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 92 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0002	0.0002	0.0002	0.0002	0.0002
200	0.0008	0.0006	0.0006	0.0008	0.0008
>1000	0.0072	0.0058	0.0058	0.0072	0.0072

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 92 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	0.0002	0.0002	0.0002	0.0002	0.0002
200	0.0008	0.0006	0.0006	0.0008	0.0008
>1000	0.0072	0.0058	0.0058	0.0072	0.0072

TABLE 8. Rural Portable Sideband Impacts

Similarly, for Sideband emissions at the three distances from the cellular base station site (40 meters, 200 meters, and 1000 meters) for all migration paths, all noise floor rises were below 1 dB. The tables show a slight increase in interference from Sideband emissions between some scenarios deploying LTE with increased power and less cable loss (Case 4 and Case 5) than existing GSM and UMTS systems as represented by Case 1, 2 and 3. This rise in the interference floor is insignificant in practice and is still well under the 1 dB degradation in the noise floor of the Public Safety mobile receiver.

2.3 Overload Interference Impacts

	PS RECEIVER BANDWIDTH = 25 KHz				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**5000 W**	**4000 W**	**4000 W**	**5000 W**	**4000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	YES (-21.1)	YES (-22)	YES (-22)	YES (-21.1)	YES (-22)
200	YES (-22.2)	YES (-23.2)	YES (-23.2)	YES (-22.2)	YES (-23.2)
>1000	NO	NO	NO	NO	NO

	PS RECEIVER BANDWIDTH = 12.5 KHz				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**5000 W**	**4000 W**	**4000 W**	**5000 W**	**2000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	YES(-21.1)	YES(-22.0)	YES (-22)	YES(-21.1)	YES (-22)
200	YES(-22.2)	YES(-23.2)	YES (-23.2)	YES(-22.2)	YES (-23.2)
>1000	NO	NO	NO	NO	NO

TABLE 9. Non-Rural Mobile Overload Impacts

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 25 KHz CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 2 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**5000 W**	**4000 W**	**4000 W**	**5000 W**	**4000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	YES(-24.1)	YES(-25)	YES (-25)	YES(-24.1)	YES(-25)
200	YES(-25.2)	YES(-26.2)	YES (-26.2)	YES(-25.2)	YES(-26.2)
>1000	NO	NO	NO	NO	NO

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**5000 W**	**4000 W**	**4000 W**	**5000 W**	**4000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	YES(-24.1)	YES(-25)	YES (-25)	YES(-24.1)	YES(-25)
200	YES(-25.2)	YES(-26.2)	YES (-26.2)	YES(-25.2)	YES(-26.2)
>1000	NO	NO	NO	NO	NO

TABLE 10. Non-Rural Portable Overload Impacts

DISTANCE TO MOBILE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 47 m) CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 1 FIVE MHz LTE CXR, 2 UMTS CXR & 2 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**10,000 W**	**8000 W**	**8000 W**	**10,000 W**	**8000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	YES(-26.8)	YES(-27.8)	YES(-27.8)	YES(-26.8)	NO
200	YES(-21.2)	YES(-22.2)	YES(-22.2)	YES(-21.2)	YES(-25.2)
>1000	YES(-25.8)	YES(-26.8)	YES(-26.8)	YES(-25.8)	YES(-29.8)

	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 47 m)				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	YES(-26.8)	YES(-27.8)	YES(-27.8)	YES(-26.8)	NO
200	YES(-21.2)	YES(-22.2)	YES(-22.2)	YES(-21.2)	YES(-25.2)
>1000	YES(-25.8)	YES(-26.8)	YES(-26.8)	YES(-25.8)	YES(-29.8)

	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 92 m)				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	NO	NO	NO	NO	NO
200	NO	NO	NO	NO	NO
>1000	YES(-23.8)	YES(-24.8)	YES(-24.8)	YES(-23.8)	YES(-27.8)

	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 92 m)				
DISTANCE TO MOBILE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	NO	NO	NO	NO	NO
200	NO	NO	NO	NO	NO
>1000	YES(-26.8)	YES(-27.8)	YES(-27.8)	YES(-26.8)	NO

TABLE 11. Rural Mobile Overload Impacts

	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 47 m)				
DISTANCE TO PORTABLE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**10,000 W**	**8000 W**	**8000 W**	**10,000 W**	**8000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	YES(-29.8)	NO	NO	YES(-29.8)	NO
200	YES(-24.2)	YES(-25.2)	YES(-25.2)	YES(-24.2)	YES(-28.2)
>1000	YES(-28.8)	Yes(-29.8)	Yes(-29.8)	YES(-28.8)	NO

	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 47 m)				
DISTANCE TO PORTABLE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**10,000 W**	**8000 W**	**8000 W**	**10,000 W**	**8000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	YES(-29.8)	NO	NO	YES(-29.8)	NO
200	YES(-24.2)	YES(-25.2)	YES(-25.2)	YES(-24.2)	YES(-28.2)
>1000	YES(-28.8)	YES(-29.8)	YES(-29.8)	YES(-28.8)	NO

	PS RECEIVER BANDWIDTH = 25 KHz (Ant Height = 92 m)				
DISTANCE TO PORTABLE RECEIVER (METERS)	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 2 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	**10,000 W**	**8000 W**	**8000 W**	**10,000 W**	**8000 W**
Allowed Now	**YES**	**YES**	**YES**	**NO**	**NO**
40	NO	NO	NO	NO	NO
200	NO	NO	NO	NO	NO
>1000	YES(-26.8)	Yes(-27.8)	Yes(-27.8)	YES(-26.8)	NO

DISTANCE TO PORTABLE RECEIVER (METERS)	PS RECEIVER BANDWIDTH = 12.5 KHz (Ant Height = 92 m)				
	CASE 1 10 GSM CXRS (dB)	CASE 2 2 UMTS & 6 GSM CXRS (dB)	CASE 3 4 UMTS CXRS & 4 GSM CXRS (dB)	CASE 4 2 FIVE MHz LTE CXR, 2 UMTS CXR & 4 GSM CXRS (dB)	CASE 5 2 TEN MHz LTE CXR (dB)
Power/Sector	10,000 W	8000 W	8000 W	10,000 W	8000 W
Allowed Now	YES	YES	YES	NO	NO
40	NO	NO	NO	NO	NO
200	NO	NO	NO	NO	NO
>1000	YES(-26.8)	YES(-27.8)	YES(-27.8)	YES(-26.8)	NO

TABLE 12. Rural Portable Overload Impacts

For overload interference, the tables show that such interference is possible close to the cellular base station sites, but LTE deployments did not increase the number of possibilities of such interference above that of existing deployments. The small difference in the overload levels for the near site calculations can be attributed to the path loss difference and the base station antenna discrimination. The tables also show that such cases of overload interference into Public Safety receivers could be reduced with the use of newer Public Safety receivers with overload limits around – 20 dBm (well within present design even at the current wider front end bandwidths) or the incorporation of front end filtering.

2.4 The PSD Limit

Reviewing the above tables lead to the conclusion that overload is the controlling interference mechanism. Based on this conclusion the highest PSD that can be implemented and still maintain the *status quo* in the interference environment can be determined. A PSD of 250 watts/MHz for non-rural areas and 500 watts/MHz for rural areas proposed in the previous study, which was determined to be the highest PSD limit that would not cause any additional interference into bands adjacent to the 850 MHz cellular band, was supported by this study (5000 watts/20 MHz = 250 Watts/MHz) and (10,000 Watts/20 MHz = 500 Watts/MHz).

3. Conclusions

This study addressed the interference impacts on Public Safety receivers under five different cases that are representative of AT&T's past, present, and future network comprising GSM, UMTS and LTE systems in various configurations in the cellular band where the licensee holds both the A and B spectrum blocks. The study used the operating parameters of Public Safety portable and mobile units which were considered poor by present industry standards. The study results in Tables 1 through 12 suggest that the interference environment into Public Safety portable and mobile units from 2X2 MIMO LTE cellular deployments is not appreciably different than that from existing technologies in the cellular band with a similar spectrum allocation.

Results of this "real world" study support AT&T's continued belief that a power limit based on a Power Spectral Density measure will not increase the possibility of harmful interference to adjacent bands and would maintain the "status quo" with respect to the potential impact on users of adjacent spectrum, such as the Public Safety Radio Service. This "real world" study results again supported the Power Spectral Density limit of 250 Watts/MHz in non-rural areas and 500 Watts/MHz in rural areas proposed in a previous study.